IN THE SPECIFICATION

Delete paragraph 0002, and add, as follows:

D1

[0002] Processes onto a substrate have been carried out variously and widely in manufacture of many kinds of semiconductor devices such as DRAM (Dynamic Random Access Memory)~~s~~, and liquid crystal ~~displays~~ display(LCD). Such substrate processes sometimes use a plasma-enhanced processing apparatus where a substrate process is carried out utilizing plasma generated in a process chamber. For example, a plasma-enhanced etching apparatus is often used for etching through a mask pattern formed of photo-resist. The plasma-enhanced etching apparatus carries out the etching utilizing reaction of ions, ~~activates~~ activating materials or radicals produced in the plasma. Plasma-enhanced processing apparatuses have the merits that substrate contamination scarcely occurs because process is carried out under vacuum pressure, and fine-pattern formation is easy.

Delete paragraph 0004, and add, as follows:

D2

[0004] The opposite electrode is roughly composed of a front board facing ~~to~~ the substrate and a main body in contact with the front board. The main body is made of metal because it has the role of voltage introduction port for maintaining the front board at a specific potential. The front board is removable from the main body. This is because it is required to replace the front board to a new one. Replacement of the front board is from the following reason.

Delete paragraphs 0007-0012, and add, as follows:

D3

[0007] In the described conventional apparatuses, when plasma is generated, temperature of the front board increases, accepting heat from the plasma. Because the front board is completely fixed with the main body at positions of screwing, large internal stress is generated at those positions. Therefore, if the front board is

D3 made of fragile material such as silicon mono-crystal, the front board is sometimes cracked or broken before a replacement period.

[0008] If the front board is cracked or broken before a replacement period, it leads to increase of cost for the front ~~boards~~ board. If the front board is broken while a substrate is processed, the broken front board may fall on the substrate under processing, destroying elements formed on the substrate. When it is worst, the substrate cannot be used no longer. As a result, large D4 Cont loss that makes the yield decrease much is brought. In addition, to resume the process requires steps of; temporarily venting the process chamber to open it to the atmosphere, eliminating the broken front board, and then pumping the process chamber again. This operation may make productivity much decrease because it takes long time.

[0009] Besides, temperature distribution on the front board tends to be out of uniform in the structure where the front board is screwed with the main body. The front board is in much more D3 contact with the main body at the screwing area, ~~contrarily being in less contact at the~~ as compared to other area. When temperature of the front board increases by heat from the plasma, heat is transferred to the main body largely through the screwing area ~~in much contact~~, contrarily transferred much less through the other area. As a result, temperature of the front board at the screwing area is lower than the other area, thus making temperature distribution on the front board out of uniform. If the main body has a cooling mechanism that cools the front board by depriving the front board of heat, this non-uniformity of temperature distribution becomes more serious.

[0010] Temperature of the substrate facing ~~to~~ the front board increases by receiving heat from the front board. When temperature of the front board is out of uniform, temperature of the substrate becomes out of uniform as well. As a result, a process onto the substrate becomes out of uniform as well.

[0011] Taking the plasma-enhanced etching as an example, the above problem is described. Reaction in the plasma-enhanced etching is the one competing to the thin-film deposition by chemical substance produced in the plasma. The etching does not much depend on temperature because it is enabled mainly from effect of ion. On the other hand, the thin-film deposition highly depends on temperature because it is enabled from effect of neutral polymer or activate. If there is the relation that the deposition rate increases as temperature decreases, the thin-film deposition is not promoted on the high-temperature surface area of the front board. As a result, etching rate on the substrate becomes lower at the area facing ~~to~~ the low-temperature area of the front board, because neutral polymer or ~~activate~~ activating material is deposited on the substrate to impede the etching. Therefore, etching rate on the substrate ~~is lower~~ becomes low at the area facing ~~to~~ the high-temperature area of the front board, and higher at the area facing the low-temperature area of the front board.

D3 cont

[0012] Not only the plasma-enhanced etching but also other plasma-enhanced processes have the described problem. Plasma-enhanced processing apparatuses comprising a front board facing ~~to~~ a substrate generally have the problem that temperature non-uniformity of the front board leads to non-uniformity of the substrate temperature, which deteriorates homogeneity of the substrate process.

Delete paragraphs 0014-0015, and add, as follows:

D4

[0014] To accomplish this object, the invention presents ~~a~~ plasma-enhanced processing apparatus, comprising; a process chamber in which a substrate is processed, a pumping system that pumps the process chamber, a gas-introduction system that introduces process gas into the process chamber, a plasma-generation means that generates plasma in the process chamber by applying energy to the process gas, a substrate holder that holds the substrate in the process chamber, wherein an opposite electrode facing ~~to~~ the

substrate held by the substrate holder is provided, and the opposite electrode comprises a clamping mechanism that clamps the front board to support it.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Fig. 1 is a front cross-sectional view of the plasma-enhanced processing apparatus of the first embodiment of the invention.

Fig. 2 is a cross-sectional view showing installation structure of the front board ~~5~~ in the apparatus shown in Fig.1.

Fig. 3 is a ~~plane~~ plan view of the front board ~~5~~ in the apparatus shown in Fig.1.

D4 ent

Fig. 4 is a cross-sectional view of the front board ~~5~~ shown in Fig. 3.

Fig. 5 explains the advantage with regard to temperature control of the front board ~~5~~, showing temperature change of the front board ~~5~~ in repeating the etching.

Fig. 6 is a front cross-sectional view of the main part of the plasma-enhanced processing apparatus of the second embodiment.

Fig. 7 is a front cross-sectional view of the main part of the plasma-enhanced processing apparatus of the third embodiment.

Fig. 8 is a front cross-sectional view of the main part of the plasma-enhanced processing apparatus of the fourth embodiment.

Fig. 9 shows a result of an examination for relationship between screwing torque of ~~the~~ a clamping plate ~~631~~ and contact of the front board ~~5~~ onto the main body ~~61~~.

Fig. 10 shows a result of an examination for relationship between screwing torque of the clamping plate ~~631~~ and reproducibility of the etching.

Delete paragraph 0017, and add, as follows:

D5

[0017] The apparatus shown in Fig.1 comprises a process chamber 1 in which a substrate 9 is processed, a gas-introduction system 2 that introduces process gas necessary for plasma-enhanced

etching into the process chamber 1, a plasma-generation means 3 that generates plasma in the process chamber 1 by applying energy to the process gas, a substrate holder 4 that holds the substrate 9 in the process chamber 1, and an opposite electrode 6 having a front board 5 facing ~~to~~ the substrate 9 held by the substrate holder 4.

D5 cut

Delete paragraph 0021, and add, as follows:

[0021] The substrate holder 4 is roughly composed of a main bock 41 and holding block 42 in contact with the main bock 41. The main block 41, with which the ~~the~~ holder-side HF source 31 is connected, is made of metal such as aluminum or stainless steel. The holding block 42, on which the substrate 9 is held, is made of dielectric such as alumina.

D6

Delete paragraph 0025, and add, as follows:

[0025] The plasma generated in the process chamber 1 is sustained by ions and electrons released from the substrate 9 through the etching. Density of the plasma tends to be lower at the space region facing ~~to~~ the periphery of the substrate 9 than the space region facing ~~to~~ the center of the substrate 9. This is another reason why the correction ring 45 made of the same material as the substrate 9 is provided. The correction ring 45 supplies ions and electrons with the space region facing ~~to~~ the periphery of the substrate 9, thereby making the plasma density uniform.

D7

Delete paragraph 0027, and add, as follows:

[0027] Next are described details of the front board 5 and the opposite electrode 6, which greatly characterize this embodiment. Fig. 2 is a cross-sectional view showing <u>an</u> installation structure of the front board 5 in the apparatus shown in Fig. 1. Fig. 3 is a ~~plane~~ <u>plan</u> view of the front board 5 in the apparatus shown in Fig. 1. Fig. 4 is cross-sectional view of the front board 5 shown in Fig. 3.

D8

Delete paragraphs 0029 and 0030, and add, as follows:

D9

[0029] As shown in Fig. 1, the front board 5 faces ~~to~~ the top surface of the substrate holder 4 in parallel. As shown in Fig. 3, the front board 5 is circular. The main body 61 is made of metal such as aluminum or stainless steel. As shown in Fig. 1, the main body 61, which cross-sectional shape is like reversed "T", is composed of a circular board portion having the same radius as the front board 5, and an upright support portion which is coaxial with the circular portion.

[0030] An earthing part 72 and an extra HF source 73 are connected in parallel with the main body 61 interposing a switch 71. The switch 71 enables to select whether the main body 61 is maintained at the earth potential or applied HF voltage ~~to~~. Frequency of the extra HF source is preferably different from the holder-side HF source 31. This is to prevent generation of high-energy load caused from interference of two HF waves. Frequency of the extra HF field 73 may be about 10-100MHz. Output power of the extra HF field 73 may be about 300-3000W.

Delete paragraph 0033, and add, as follows:

D10

[0033] A concavity (not shown) is provided at the down surface of the main body 61. This concavity is shallow, having depth of about 0.01-1.00mm. The ~~plane~~ plan view of this concavity is coaxial with the front board 5 and slightly smaller than the front board 5 in radius. The front board 5 is in contact with the main body 61 at the outside of the concavity.

Delete paragraph 0036, and add, as follows:

D11

[0036] The front board 5 is made of silicon poly-crystal as described. This is much relevant to that the front board 5 is not screwed but clamped by the clamping mechanism 63. The front board 5 is preferably made of material capable of being etched as described. As such the material, quartz, i.e. silicon oxide, or

carbon is adopted conventionally. For example, in etching a silicon oxide film formed on the substrate 9, the front board 5 made of quartz is etched by the same mechanism as on the substrate 9. In the case that the front board is made of carbon, when plasma is generated, introducing carbon fluoride gas, ~~activates~~ activating material or ions from the plasma ~~react~~ reacts with the front board 5 to produce volatile carbon fluoride, thus etching the front board 5.

D11 cut

Delete paragraph 0040, and add, as follows:

[0040] As shown in Fig. 2, the clamping plate 631 and the clamping screw 632 are covered by a protector 64. The protector 64 is to make the clamping plate 631 and the clamping screw 632 not exposed to the plasma. If the clamping plate 631 and the clamping screw 632 are exposed to the plasma, those are possibly etched, releasing material that could contaminate the substrate 9. If the clamping plate 631 and the clamping screw 632 ~~is~~ are made of material that is not etched, when the clamping plate 631 and the clamping screw 632 are exposed to the plasma, products in the plasma are deposited, causing the problem that particles are produced from the peeled deposit. Considering this point, the protector 64 covers the clamping plate 631 and the clamping screw 632. The protector 64 is made of material that causes no problem if it is etched. Such material is quartz or carbon.

D12

Delete paragraph 0043, and add, as follows:

[0043] A sheet 5' made of carbon (hereinafter called "carbon sheet") is provided between the main body 61 and the front board 5. The carbon sheet is to enhance thermal contact of the front board 5 and the main body 61. The surfaces of the front board 5 and the main body 61 in contact with each other are not completely flat, i.e., slightly uneven. Therefore, there is a minute gap between the front board 5 and the main body 61. This gap has low thermal conductivity because it is under vacuum pressure. The carbon sheet

D13

is filled with this gas ~~with~~, thereby enhancing the thermal conductivity. A sheet formed of compressed carbon fiber can be used as the carbon sheet. Thickness of the carbon sheet is 0.02-4mm, preferably 2mm. Instead of the carbon sheet, a sheet made of conductive rubber or indium can be used for the same purpose.

D13 cut

~~Delete paragraph 0047,~~ and add, as follows:

[0047] Size of the front board 5, i.e., area of the surface facing ~~to~~ the substrate 9, is preferably one to two times of the substrate 9. When the front board 5 is smaller than the substrate 9, the etching rate may decrease at the periphery of the substrate 9, causing non-uniformity of the etching rate, because the plasma density decreases at the space region adjacent to the periphery of the substrate 9. On the other hand, when the front board 5 is larger than two times of the substrate 9, the discharge space may be expanded wastefully, bringing the problem that size of the process chamber 1 is enlarged.

D14

~~Delete paragraph 0057, and add,~~ as follows:

[0057] In the apparatus where the front board 5 is screwed, therefore, average temperature t_a of front board 5 within the time of the one etching process, hereinafter called "time-average temperature", gradually increases as the etching process is repeated and repeated. After all, the time-average temperature t_a reaches thermal equilibrium at a temperature, increasing no more. "Thermal equilibrium" here means that total quantity of heat given to the front board 5 within the time of the one etching process is equal to total quantity of heat simultaneously deprived from the front board 5 ~~of~~. Though the time-average temperature reaches the thermal equilibrium, total quantity of heat given to the substrate 9 from the front board 5 within the time of each etching process differs until then, because the time-average temperature t_a differs. As a result, etched quantity in each etching process may differ.

D15

Delete paragraph 0069, and add, as follows:

[0069] Therefore, there is no member projecting downward from the down surface of the opposite electrode 6 in the third embodiment. The structure of the perfect parallel-planar-electrodes ~~type~~ is established. Uniformity of the plasma along directions parallel to the substrate 9 is improved more than the second D14 embodiment, resulting in that uniformity of the etching onto the substrate 9 is improved. The clamping plate 631 is preferably made of material not contaminating the substrate 9, for example silicon mono-crystal, because it probably may be exposed to the plasma.

Delete paragraph 0079, and add, as follows:

[0079] As shown in Table 2, in the structure where the front board is screwed directly on the main body, the front board was broken when it was screwed with torque of 0.5Nm or more. It means that the front board must be screwed with torque below 0.5Nm. On D17 the other hand, the screw loosening happened at the 0.08Nm torque. This was resulted from that the front board and the screw repeated thermal expansion and thermal shrinkage ~~alternatively~~ alternately as the etching process and the etching interval are repeated alternately ~~alternatively~~. The screw supposedly loosened from difference of thermal expansion coefficient or thermal shrinkage coefficient. It is considered that installation or thermal contact of the front board onto the main body had become much insufficient from such the screw loosening.

Delete paragraph 0084, and add, as follows:

[0084] As shown in Fig.10, in the case of the 0.08Nm screwing D18 torque, etching rate dropped by the fifth times of the etching process. In other words, reproducibility of the etching decreased largely. This is supposedly resulted from that temperature of the front board, specifically the time-average temperature, rapidly increased because of the bad thermal contact onto the main body.

Anyway, this case probably may cause problems such as excessive etching or etching shortage because of low reproducibility. The reason why etching rate in the case of the ~~0.08Nm~~ 1.2Nm torque is higher than in the case of the ~~1.2Nm~~ 0.08Nm torque is supposedly that temperature of the substrate was maintained in an adequate range because heat irradiation that the substrate received was reduced, resulting from that the front board was cooled efficiently.

D18 cut

Delete paragraph 0086, and add, as follows:

[0086] There are many compositions of the clamping mechanism 63 other than the described one. For example, the clamping mechanism 63 may be composed of a couple of clamping plate. The claming plate 631 may be pressed onto the front board 5 with an elastic member like spring. The clamping plate 631 may be installed by ~~another~~ means other than screwing. Except the front board 5, the clamping plate 631 may be fastened on ~~another~~ a member other than the main body 61.

D19